MATERIALS SCIENCE AND TECHNOLOGY

Ateneo - New strategies for Surface Enhaced Raman Scattering-based sensing in complex biological samples

Funded By	Politecnico di TORINO [P.iva/CF:00518460019]
Supervisor	NOVARA CHIARA - chiara.novara@polito.it
Contact	
Context of the research activity	The research project aims at developing metallic and metal-dielectric nanostructures optimized for SERS spectroscopy and imaging with applications in biomedicine and in the agri-food sector. The activity focuses both on the synthesis of the SERS active nanoparticles and on their surface functionalization with biomolecular probes for the achievement of sensitive, reliable, quick and cheap SERS sensing platforms to be applied in the field of early cancer diagnosis and food safety assessment.
Objectives	Surface Enhanced Raman Scattering (SERS) is a vibrational spectroscopy with great potential for biosensing applications in diverse fields, from the biomedical to the agri-food one. SERS technique exploits the huge enhancement of the Raman signal of molecules adsorbed on nanostructured noble metals to allow their detection at very low concentrations, even in miniaturized setups for on-site analyses. The achievement of reliable, specific and sensitive biosensors requires however to merge the fine tuning of the optical properties of the SERS-active nanoparticles with the development of proper detection strategies through the use of specific biomolecular receptors. In this context, the PhD project will be focused on the synthesis of plasmonic nanoparticles for the SERS analysis of biological samples including the detection and quantitation of different analytes, such as cancer biomarker, food contaminants, metabolites and microorganisms. Both colloidal systems and in situ grown nanostructures on dielectric substrates will be explored to achieve a high and reproducible SERS enhancement together with a high stability in biological environments. The synthesized nanoparticles will be coupled to different innovative bioreceptors in order to obtain high binding selectivity towards specific analytes. Chemical modification of such biomolecular probes will be carried out to maximize their performance in SERS. The project will yield innovative SERS-active systems and SERS-based detection methods that can be applied in Point of Care applications, taking advantage of benchtop and portable Raman spectrometers. This will pave the way for the application of SERS technique in clinical and in-line contexts with a potential impact in medical biochemistry, microbiology and agri-food safety.

	The research activity of the candidate will fit into this framework and will pursue the following objectives: • Design and optimization of the synthesis of different types of SERS-active substrates including colloidal nanoparticles and metal-dielectric nanostructures on solid supports (semiconductive and elastomeric matrices decorated with plasmonic nanoparticles). • Design and optimization of innovative chemical and biological functionalization protocols devoted to the selective binding of specific analytes on colloidal/metal-dielectric nanostructures. • Optical and morphological characterization of the obtained bare and functionalized nanostructures. • Customization of the biomolecular probes through the chemical modification of the receptors (e.g. conjugation with reporters or anchoring groups). • Integration of the developed biofunctionalized nanostructures in microfluidics.

Skills and competencies for the development of the activity	The candidate should hold a Master Degree in Chemistry or related disciplines. The following competencies/skills, which deal with the experimental activity, are required: • knowledge of the main synthesis methods of plasmonic nanoparticles and of biofunctionalization techniques of metallic surfaces; • knowledge of optical spectroscopic techniques (Raman, UV-Visible, FT-IR and fluorescence); • knowledge of bioconjugation methods and related purification and characterization techniques; • ability to work in interdisciplinary teams; A good knowledge of written and spoken English is a pre-requisite.